

Dec. 18, 1923.

1,478,087

W. WILSON

VACUUM TUBE

Filed Nov. 21, 1919

Fig. 1.

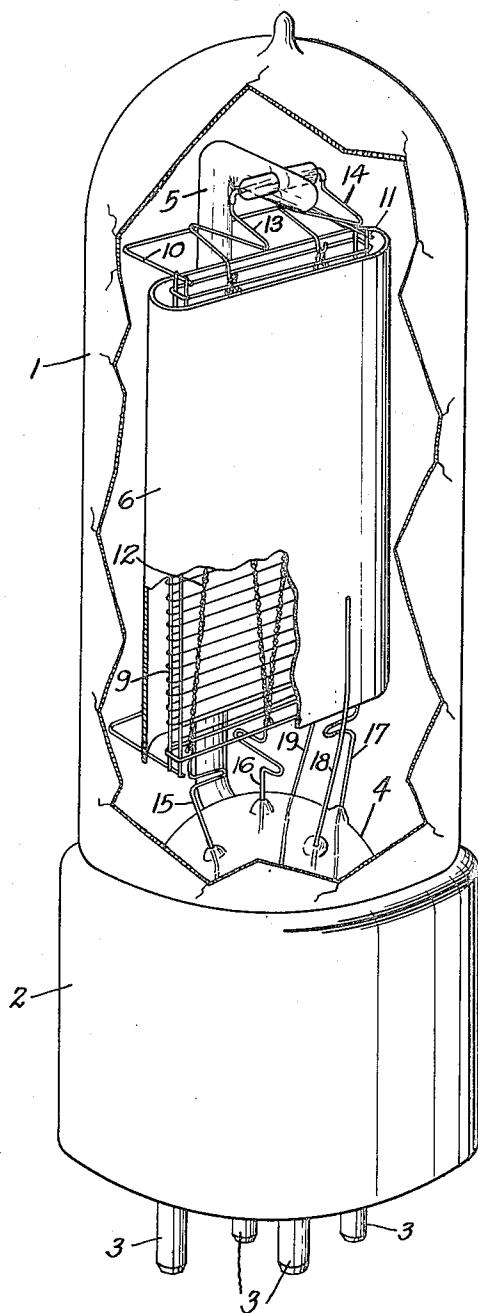
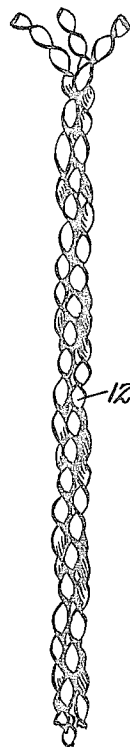


Fig. 2.



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UNITED STATES PATENT OFFICE.

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VACUUM TUBE.

Application filed November 21, 1919. Serial No. 339,744.

To all whom it may concern:

Be it known that I, WILLIAM WILSON, a subject of the King of Great Britain and Ireland, residing at Maplewood, in the county of Essex, State of New Jersey, have invented certain new and useful Improvements in Vacuum Tubes, of which the following is a full, clear, concise, and exact description.

This invention relates to vacuum tubes and has particular reference to a new and improved electrode structure therefor and a method of making the same.

An object of the invention is to provide an electrode structure which has a much longer life than such structures have at present.

The invention is concerned, in one form, with an improved cathode for vacuum tubes. The particular types of vacuum tubes to which this invention is applicable are as follows:—

1. That form of vacuum tube in which there is the highest degree of vacuum commercially practicable. The audion, which is used in telephone and telegraph signalling is a type of such a tube. This tube does not depend for its effective operation upon the gas present; in fact, any appreciable amount of gas within the tube is inimical to its successful operation.

2. That type of vacuum tube in which the presence of gas is required to some appreciable degree for the proper action of the tube. A Von Lieben tube is a tube of this type.

The use of my invention is, in the first place, particularly useful in pumping out both of the above mentioned types of vacuum tubes; in the second place, it is useful in the working of the type of vacuum tube mentioned in paragraph 2 above; in the third place, it is useful in the working of the type of vacuum tube mentioned in paragraph 1 above, although the advantage of my invention in this type of tube is not so great, as far as the effect of gas on the cathode is concerned, because the amount of gas present in this type of tube is exceedingly small.

As heretofore constituted, filaments have been subject to several defects which have materially affected the efficiency of their operation. One difficulty with filamentary cathodes has been that in order to get a given emissivity from a filament in a vacuum

tube it has been found necessary to heat the single filament to such a degree that its life is considerably reduced because of the high temperature at which it is necessary to operate it. Another difficulty has been that when subjected to widely varying temperatures the filament has been distorted with respect to its normal space relations to the other electrodes of the tube and consequently the operating characteristics of the tube have been varied by this distortion. Still another difficulty that may exist is that bright spots may develop on the filament if gas is present in the tube even in the most minute quantities, due to an excessive bombardment of the filament by the positive ions resulting from the ionization of this gas. These bright spots are centers of excessive heat which have resulted in the fusion of the filament or the peeling off of the coating therefrom. This results in the serious impairment or complete suspension of the operation of the tube.

The invention, which overcomes these difficulties, comprises, in general, a cathode which is made up of several strands twisted together. In vacuum tubes, such as audions, these strands are often, although not necessarily, coated with some substance, such as the oxides of the alkaline earth metals, to increase the emissive capacity of the filament. A preferred form of coating for filaments is described in a U. S. Patent to Nicolson and Hull #1,209,324 issued Dec. 19, 1916, "electron-emitting cathodes and the process of manufacturing the same." If such a coating is used, the number of twists given the strands is not so great as when the strands are uncoated, since the coating, when the strands are too tightly twisted, is liable to crack. The ends of the twisted strands may be connected to the supporting structure of the tube and the electrical circuit in any of the usual manners.

The invention is illustrated in the drawing of which Fig. 1 is a perspective view of a representative type of tube using my invention and Fig. 2 is a view showing in detail the twisted strands.

As shown in Fig. 1, the invention is illustrated as applied to a vacuum tube comprising an evacuated bulb 1, to which is attached a base portion 2, which in turn supports terminals 3. Within the bulb is a stem portion 4 and extending upwardly therefrom is

a post or arbor 5 which is adapted to serve as a support for the various electrodes. An electrode 6, which in the form shown, serves as an anode, is supported from the post 5 by means of wires not shown. Another electrode 9 in the form of a cylindrical wire mesh, which in the form shown, serves as a control or grid electrode, is supported from the post 5 by means of wires 10 and 11.

As shown, the anode is in the form of a hollow cylinder having an oval cross-section. The grid electrode is situated symmetrically within the anode. Symmetrically disposed within the grid is a cathode 12 in the form of an M-shaped structure which is supported at the top by means of wires 13 and 14 extending from the stem 4.

Suitable lead-in wires 18 and 19 extend from the stem 4 to the plate and grid respectively. The wires 15 and 16 serve as lead-in wires for the current to the cathode as well as to support and tension the same. While I have described the character and arrangement of the various electrodes within the evacuated vessel, it is understood that this is only for the purpose of making clear the structure disclosed in the drawing, since my invention may equally well be applied to various other arrangements of electrodes.

It will be noted that the cathode 12 comprises an element which is built up, in this case, of two or more strands of filamentary material twisted on each other and suitably connected at its extremities to the lead-in wire. In the structure shown, these cathode strands are of platinum, preferably coated with chemicals to increase its thermionic emissivity. My invention does not inherently concern the substances of which the cathode is composed nor the kind of coating which may be applied thereto, but is concerned mainly with the idea of forming an electrode in an evacuated vessel having one or more other electrodes therein, by twisting one or more strands of filamentary material on each other.

In the operation of the device, a heating current is applied to the cathode, a potential is placed between the cathode and the plate and the tube will respond thereafter to any variations of potential which may be applied between the grid and the cathode. Assuming that a certain degree of emission is desired in the tube, and assuming that the tube is evacuated to less than a certain maximum pressure, then by means of my invention, the temperature to which the cathode should be heated to get this degree of emission is not so high as in the case of a cathode comprising only one strand and consequently the multiple strand cathode will last longer and still give the required emission.

Furthermore, from a mechanical standpoint, the fact that the cathode is formed of a plurality of strands twisted on each other

results in one which is less liable to become distorted or bent due to the action of the heat thereon and, therefore, less liable to disturb the characteristic operation of the tube since no variation in the electrode space relations will result.

When the tube is operating under full power, even under the best vacuum conditions obtainable, the number of positive ions formed is sufficient to subject the cathode to considerable ionic bombardment which is found to reduce its life, by decreasing its activity and by the formation of bright spots. If, for any reason, a bright spot is formed at any part of a cathode, the increased temperature at first causes an increased emission from that part and, consequently, the positive bombardment in the neighborhood of the bright spot increases which in turn causes the bright spot to grow and, finally, causes the cathode to burn out at that point.

By providing a cathode comprising more than one strand, we thereby increase the cathode surface so that the bombardment of any portion by positive ions has a less percentage effect than would be the case if the cathode had only a single strand. Furthermore, if any one strand burns out, the heating current can be carried, notwithstanding, by the other strand, and so an increased life of the tube is obtained.

All these advantages which are derived from the provision of this sort of cathode are not only important during the ordinary operation of the tube, but are especially important during the evacuation of the bulb since during this time the electrodes are subjected to maximum temperatures and potentials and at the same time the average gas pressure during evacuation is considerably greater than that in the finished tube. During evacuation, therefore, the electrodes are more likely to evidence the defects which have been set forth above.

The above description and specification of the structure and operation of my invention has been concerned with a type of tube shown in the drawing, which is of the type having the highest commercially practicable degree of vacuum. It is to be clearly understood, however, that my invention is equally applicable to tubes in which gas is present in greater quantities and in which the gas plays an important part in the operation of the tube.

It has been demonstrated that, whereas a tube which used the old style of cathode lasted only several hours under the operating conditions to which it was subjected, one using the cathode of my invention lasted several months.

What is claimed is:

1. A vacuum tube comprising a cathode and another electrode, said cathode com-

prising a plurality of intertwined twisted ribbons of thermionically active material.

2. A vacuum tube comprising an evacuated vessel, a cathode within said vessel, a control electrode surrounding said cathode and an anode surrounding said other electrodes, said cathode comprising a plurality of strands of material twisted on each other.

3. A vacuum tube comprising an evacuated vessel, a cathode within said vessel, a control electrode surrounding said cathode and an anode surrounding said other electrode, said cathode comprising a plurality of strands of coated material twisted on each other.

4. A vacuum tube comprising an evacuated vessel, a cathode within said vessel, another electrode surrounding said cathode, said cathode comprising a plurality of intertwined twisted strands of thermionically active material.

5. An electrode for electron discharge devices comprising a plurality of twisted strands of thermionically active material contacting with each other along substantially their entire effective length.

In witness whereof, I hereunto subscribe my name this 19th day of November A. D., 1919.

WILLIAM WILSON.